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(54) **ELECTROMAGNETIC RELAY**

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***H01H 50/00*** (2006.01)
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CPC ..... ***H01H 50/00*** (2013.01); ***H01H 9/40*** (2013.01); ***H01H 9/443*** (2013.01); *H01H 50/02* (2013.01); *H01H 50/26* (2013.01); *H01H 50/28* (2013.01); *H01H 50/305* (2013.01); ***H01H 50/54*** (2013.01)

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CPC ..... H01H 51/065; H01H 51/01; H01H 51/06; H01H 9/02; H01H 9/46; H01H 9/443; H01H 50/00; H01H 50/60; H01H 50/36; H01H 50/38; H01H 50/546; H01H 71/0235; H01H 9/34; H01H 9/44; H01H 2050/049; H01H 77/108; H01F 7/14; H01F 7/1646; H02H 1/0007; H02K 49/10
USPC ..... 335/201
See application file for complete search history.

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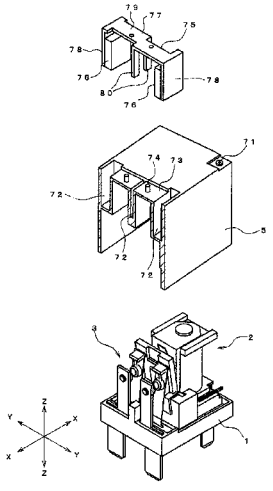
(57) **ABSTRACT**

An electromagnetic relay including a contact switching unit formed by arranging at least two contact groups, in parallel with each other and perpendicular to the touch/separation direction of the contacts, each of the contact group includes a pair of contacts that can touch and separate; an electromagnet block that drives the contact switching unit to open and close the contacts; and an arc-extinguishing member comprising a connection member made from a magnetic material and formed by a connection of protrusions that respectively protrude from both sides of a middle part in the direction of the parallel arrangement of the contact groups and between the contact groups, and also comprising permanent magnets respectively disposed at least on the opposing positions of the protrusions located on both sides of the middle part.

**13 Claims, 14 Drawing Sheets**



(51) **Int. Cl.**

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|---|---|
| ***H01H 9/40*** | (2006.01) |
| ***H01H 9/44*** | (2006.01) |
| ***H01H 50/54*** | (2006.01) |
| *H01H 50/02* | (2006.01) |
| *H01H 50/26* | (2006.01) |
| *H01H 50/28* | (2006.01) |
| *H01H 50/30* | (2006.01) |

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Fig. 1

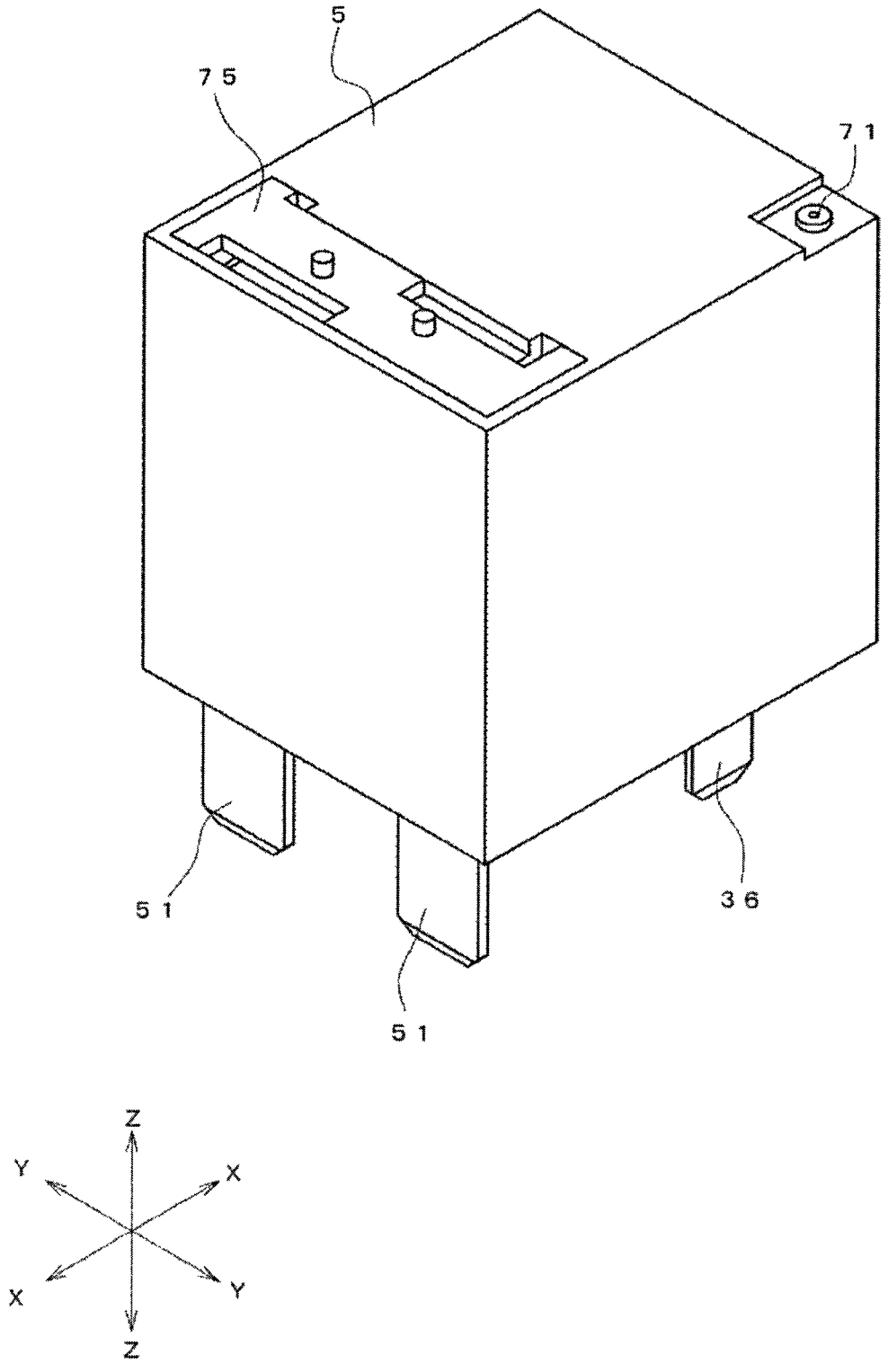


Fig. 2

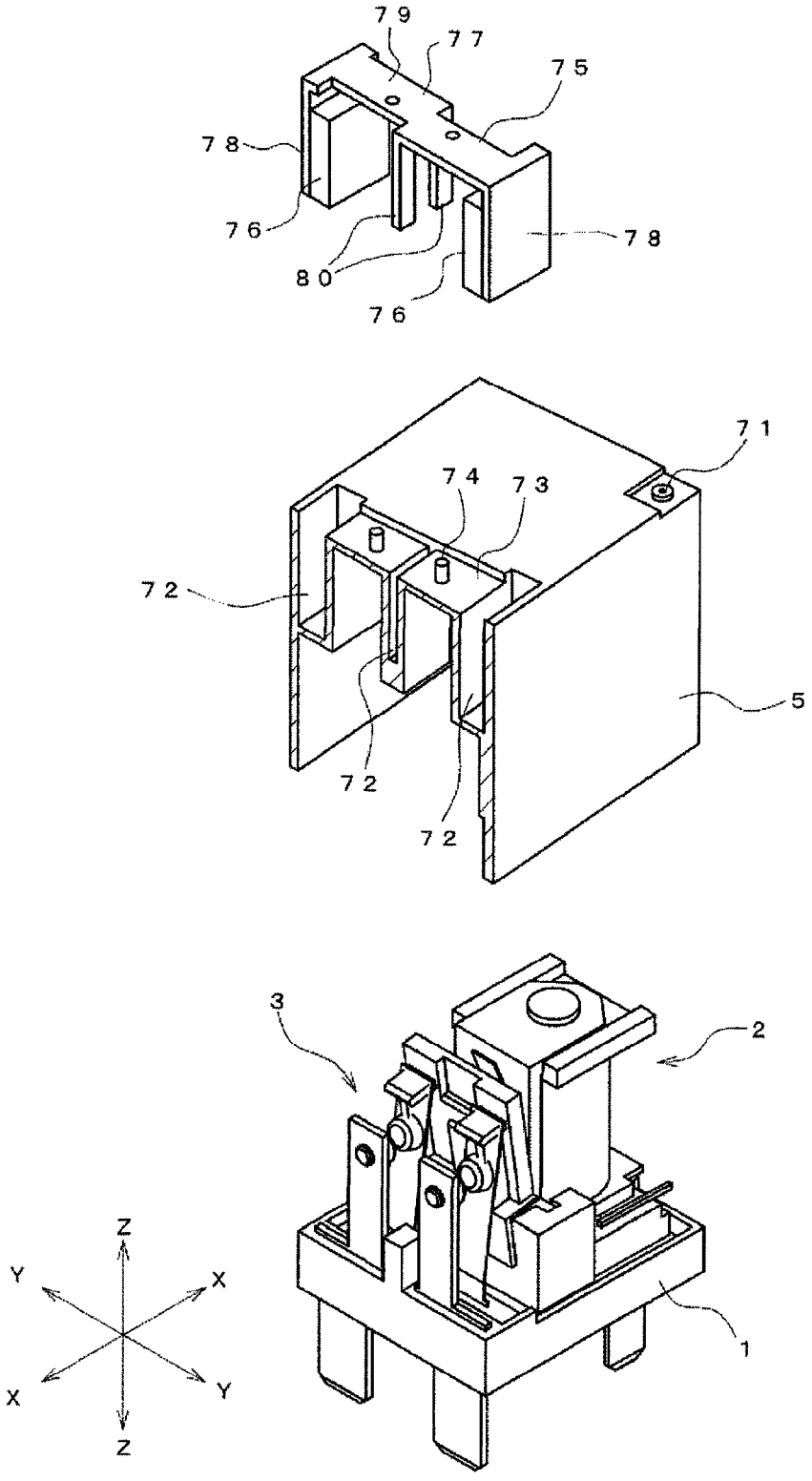


Fig. 3

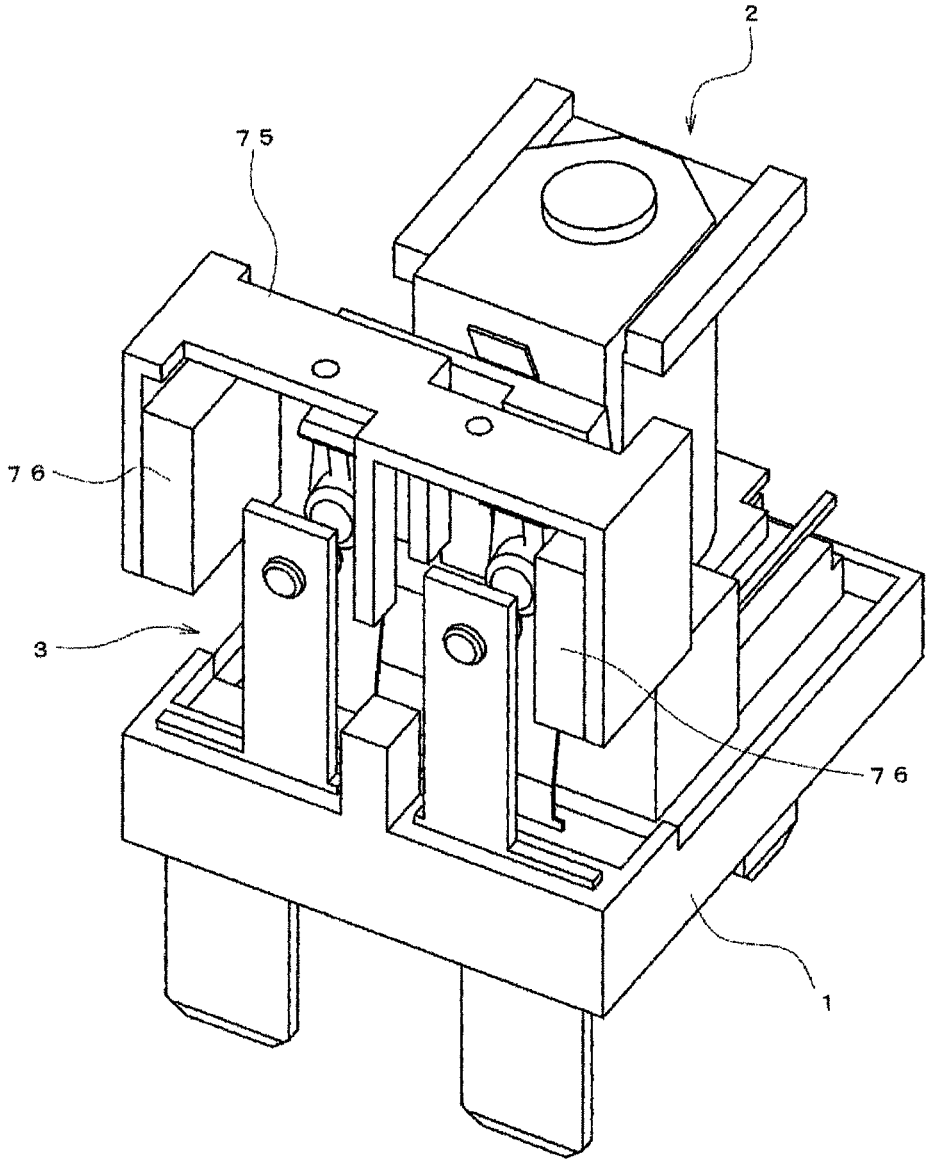


Fig. 4

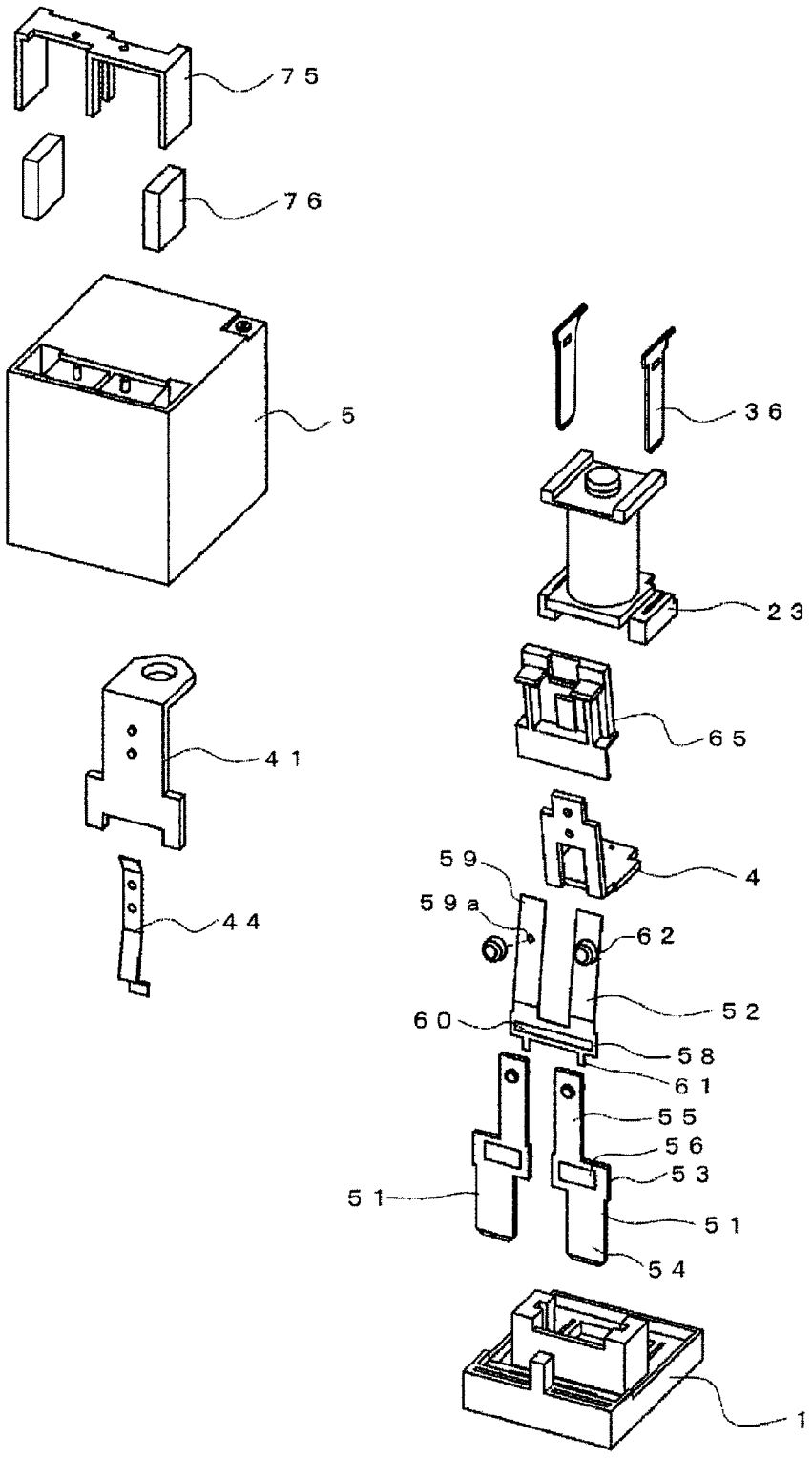


Fig. 5

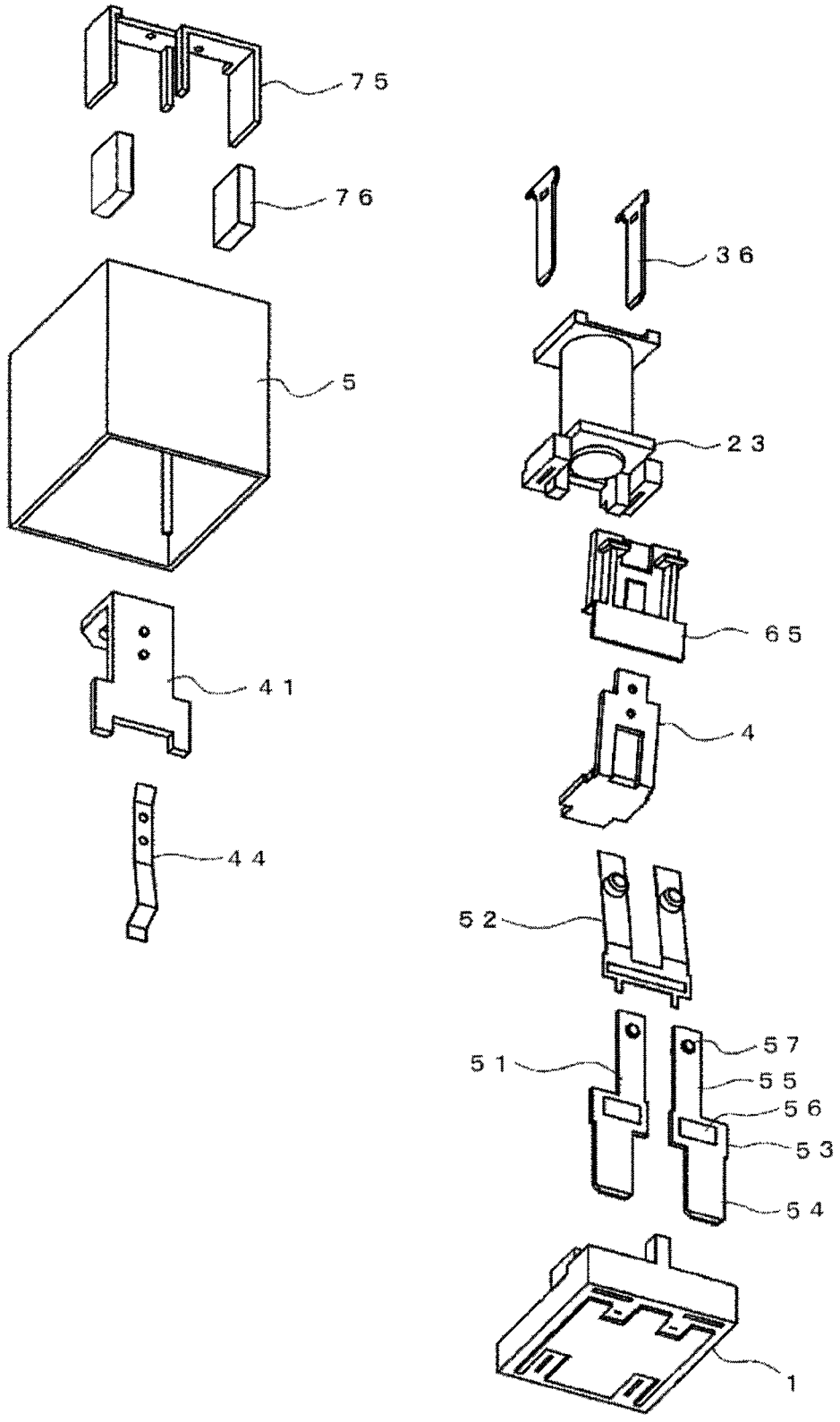


Fig. 6A

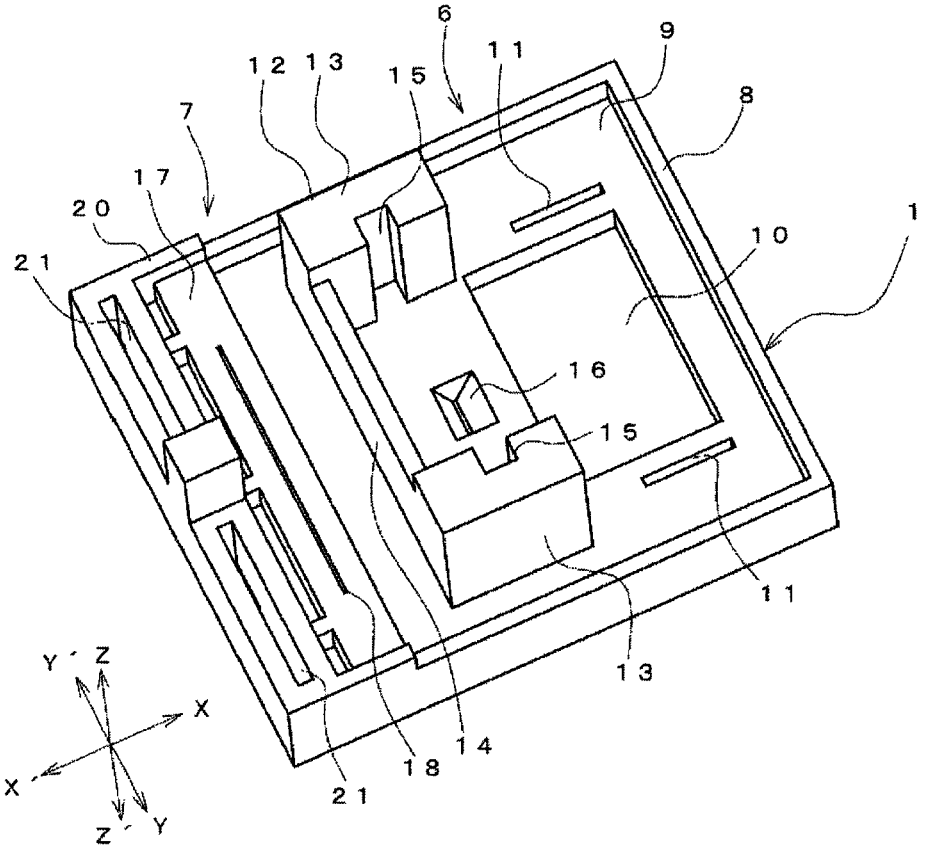
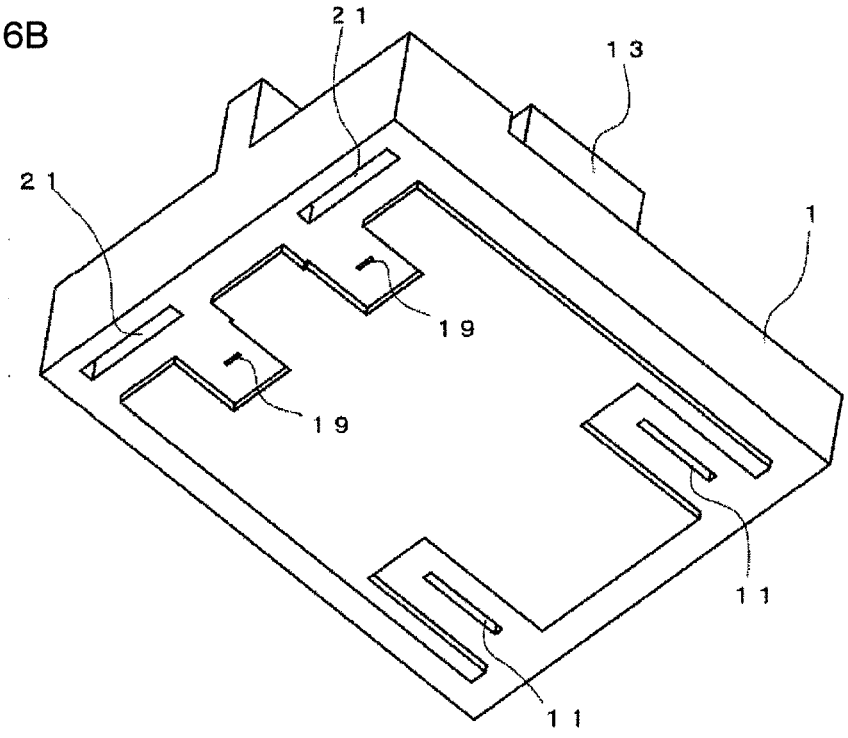

6
9
12 13
15
11
8
7
17
20
21
10
1
16
15
11
13
Y · Z
X
X
Z · Y
18
14
21

Fig. 6B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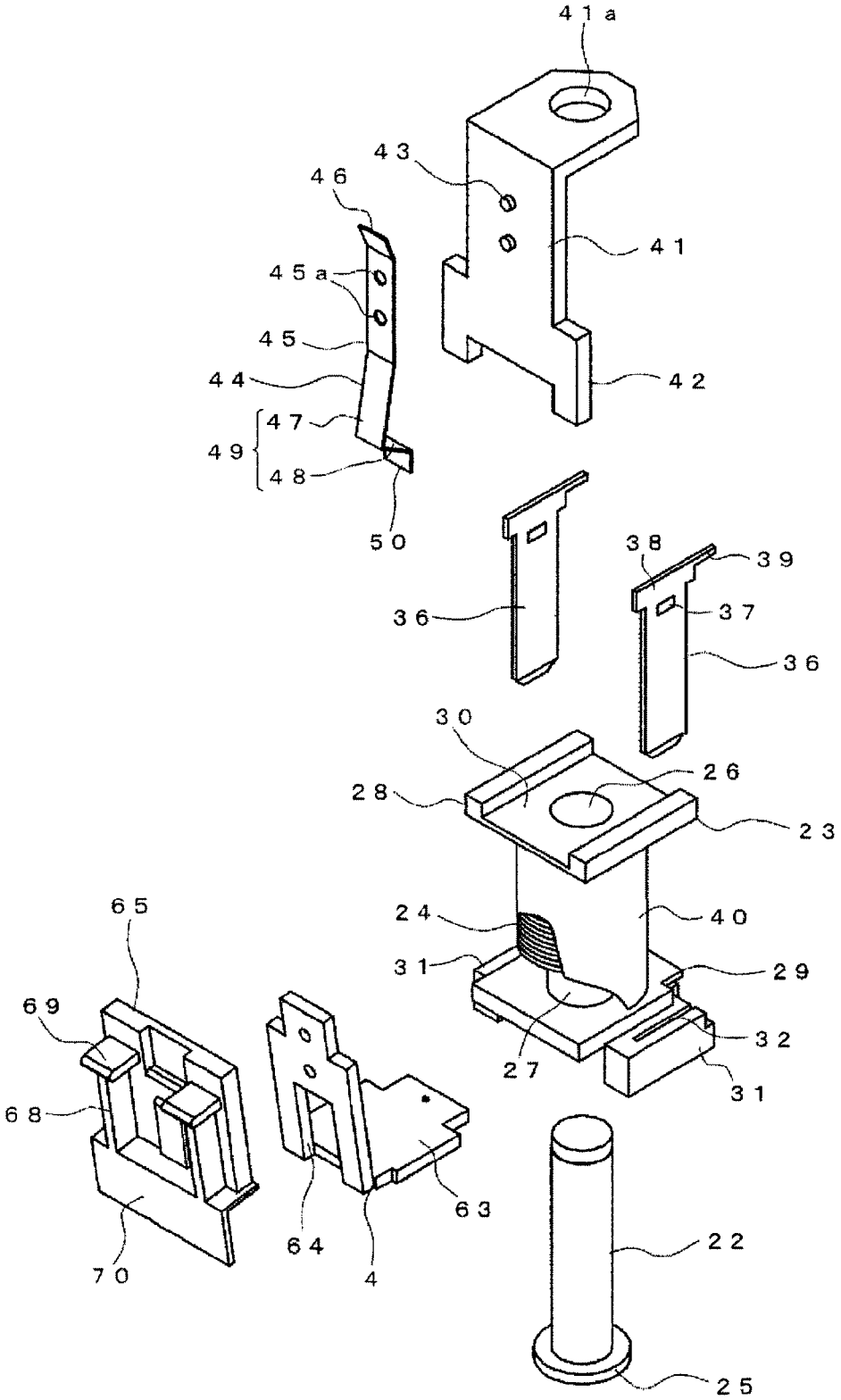
13
21
1
19
19
11
11

Fig. 7


41a
43
46
41
45a
45
42
44
47
49
48
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30
26
28
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69
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32
68
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31
63
64
4
22
70
25

Fig. 8

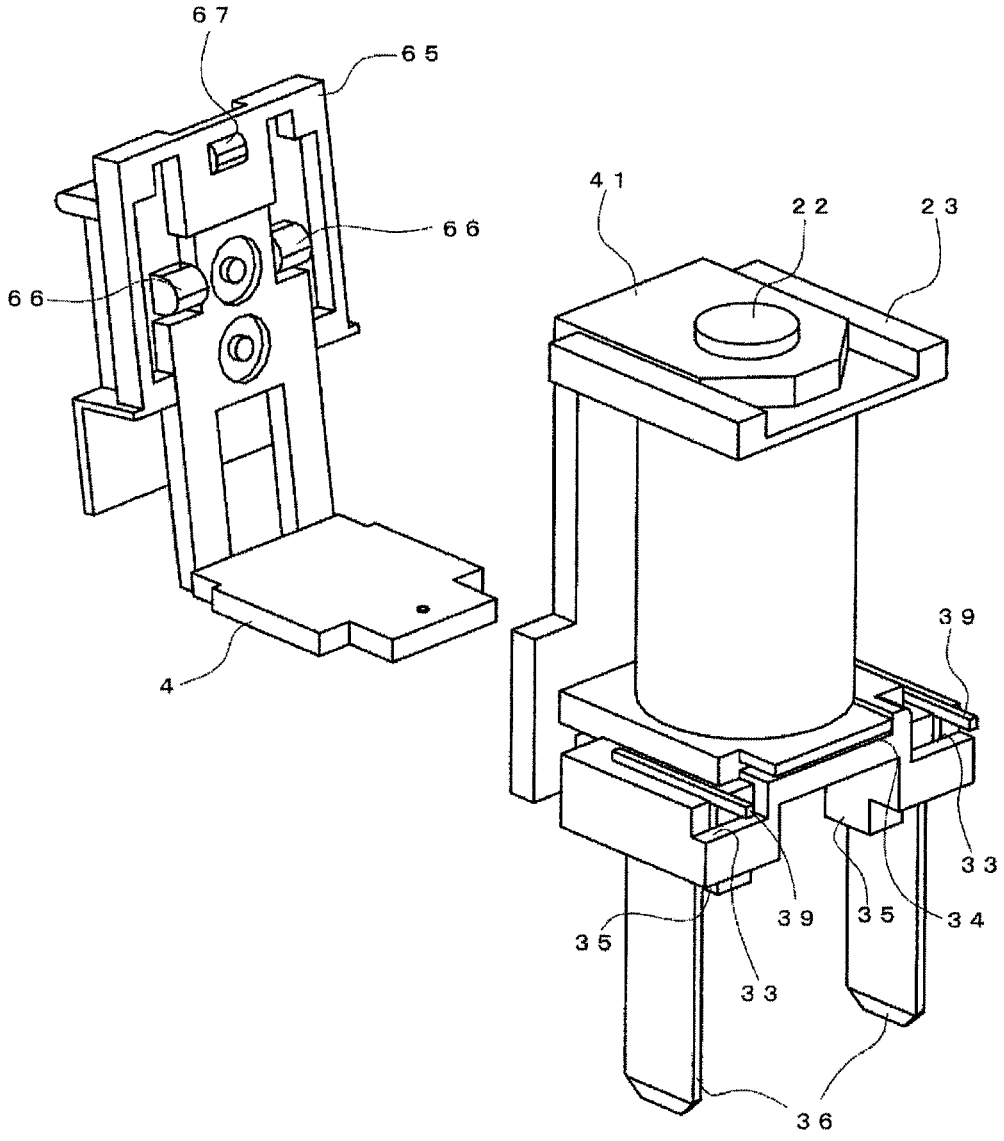


Fig. 9

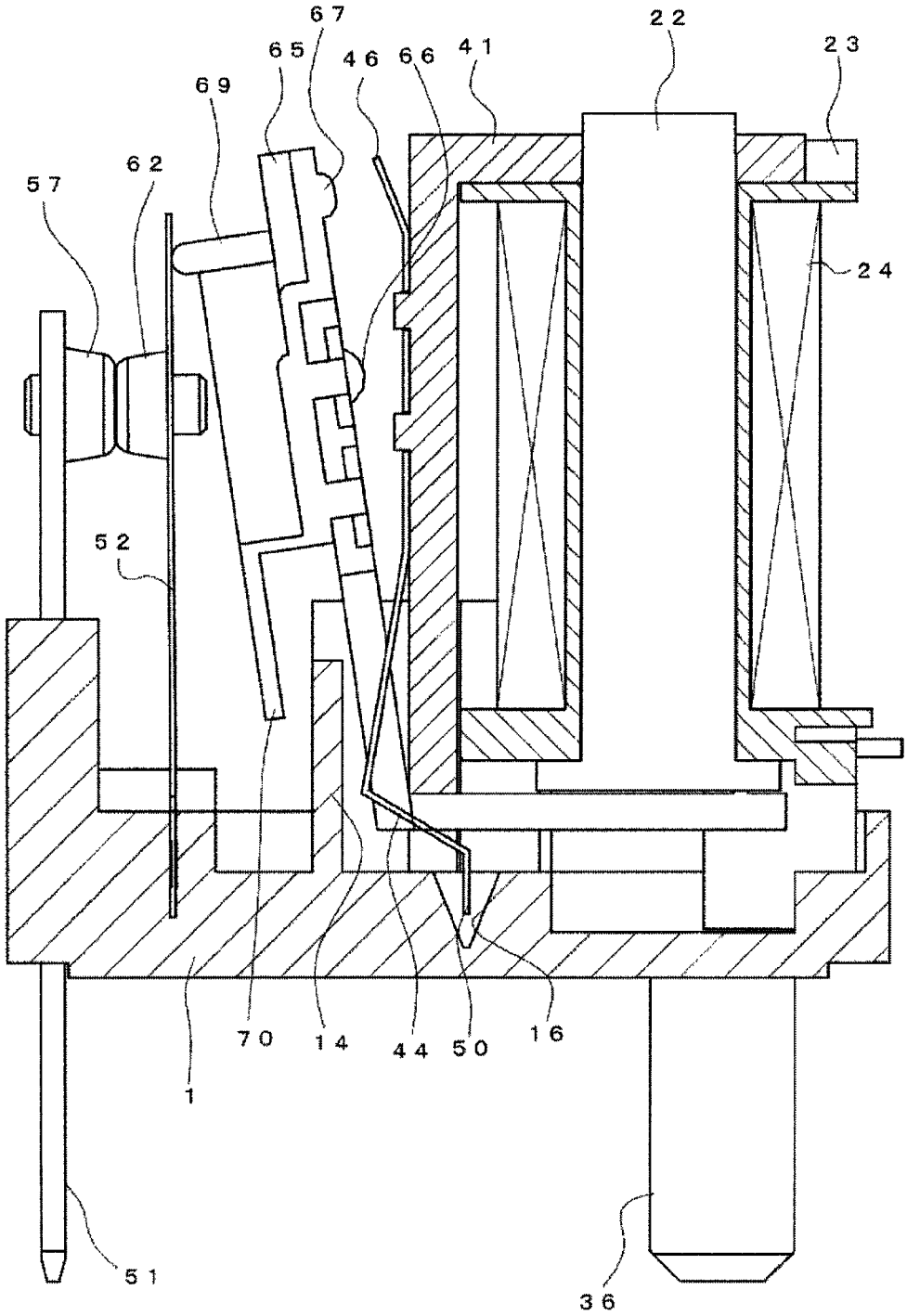


Fig. 10

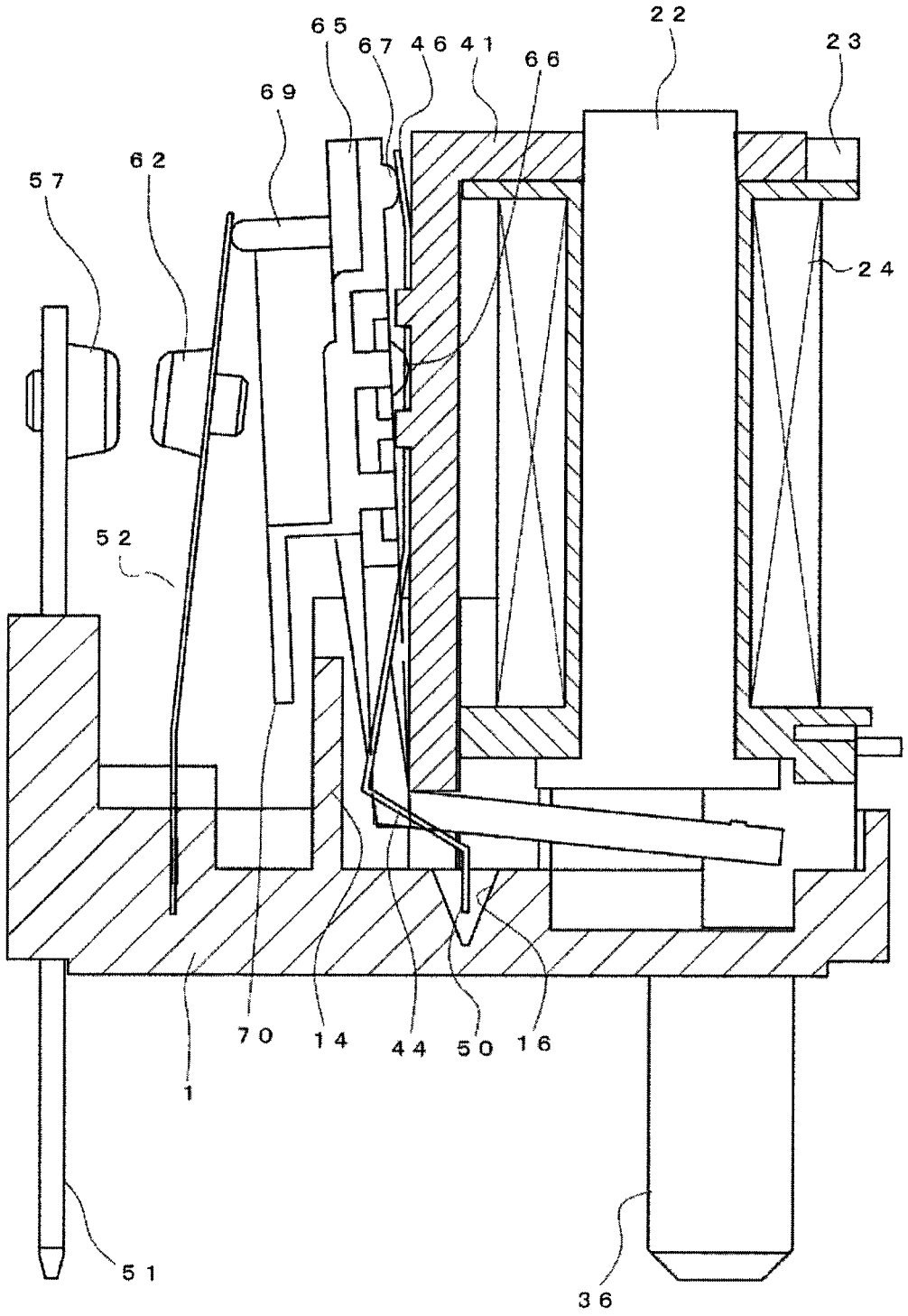


Fig. 11

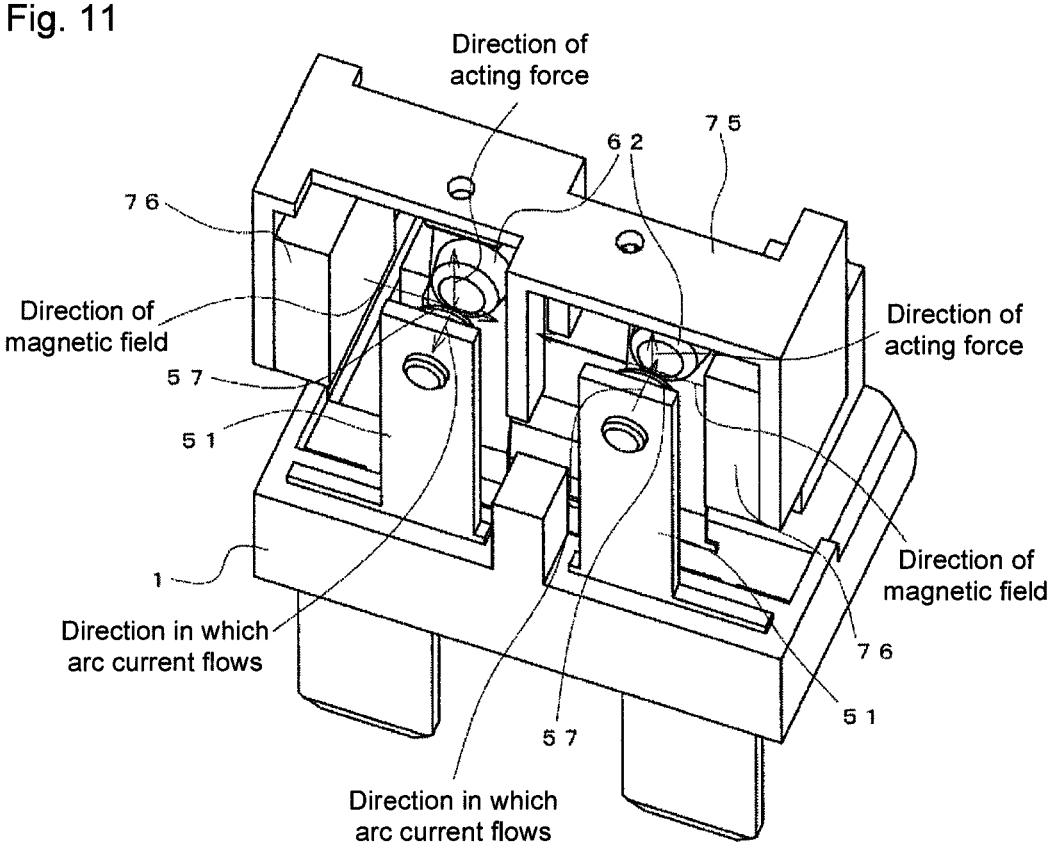

Direction of acting force
62
75
76
Direction of magnetic field
57
51
1
Direction in which arc current flows
Direction of acting force
Direction of magnetic field
76
51
57
Direction in which arc current flows

Fig. 12

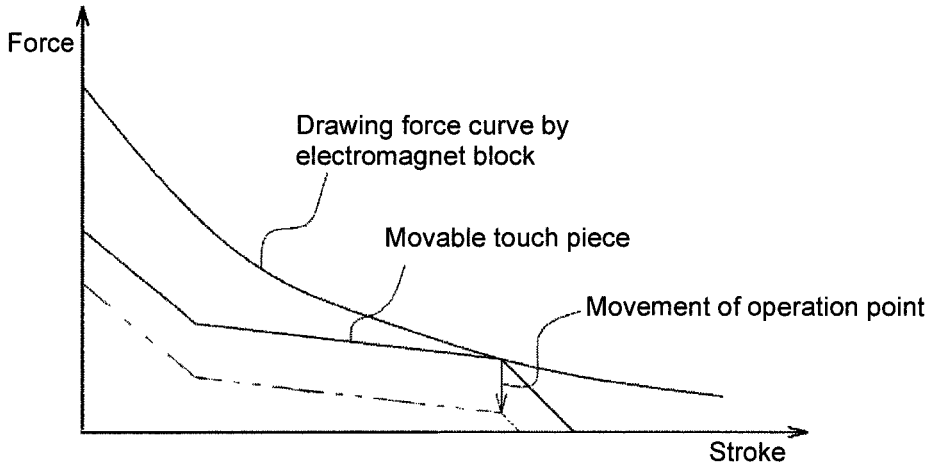
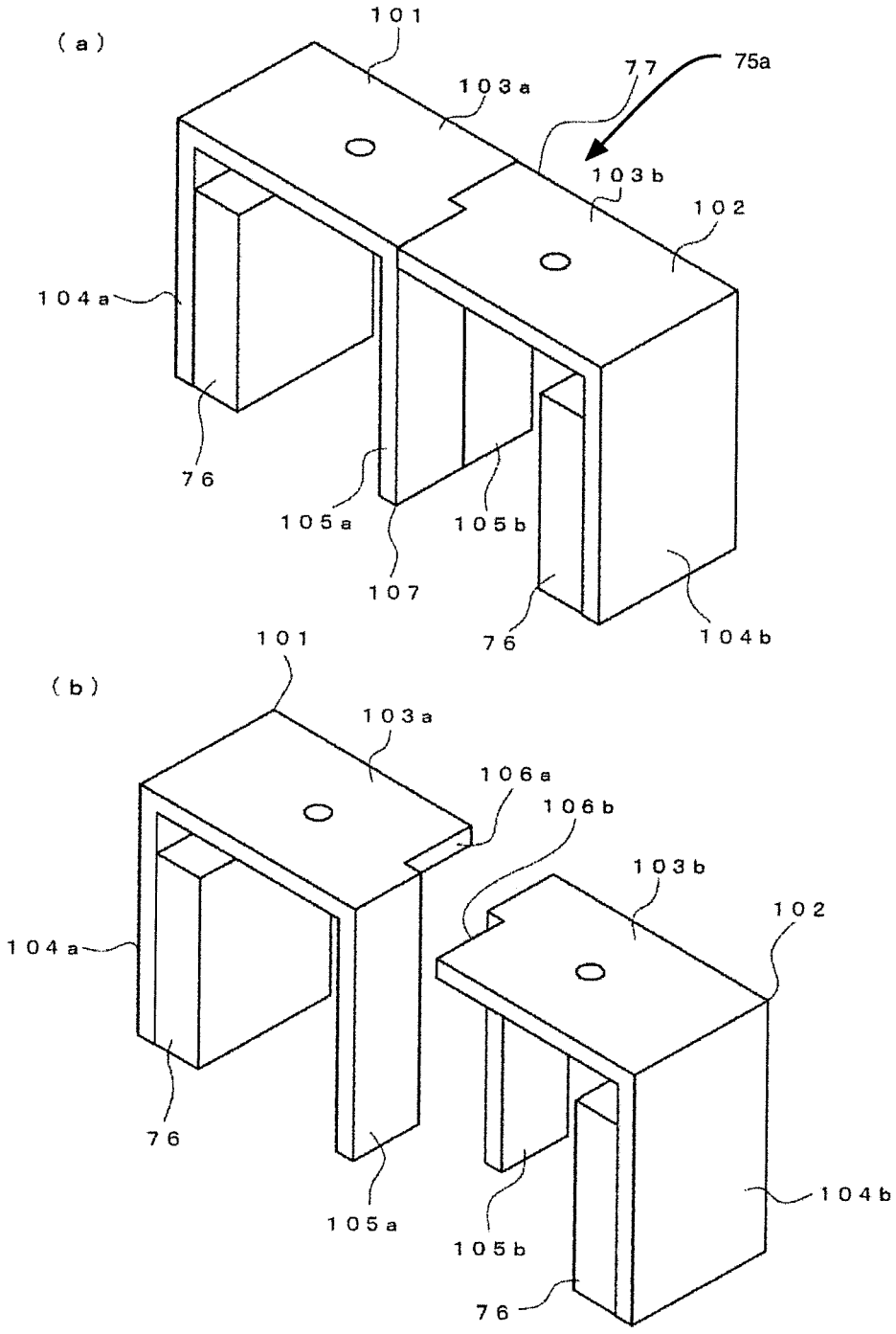

Force
Drawing force curve by electromagnet block
Movable touch piece
Movement of operation point
Stroke

Fig. 13


(a)
101
103a
77
75a
103b
102
104a
76
105a
107
105b
76
104b
(b)
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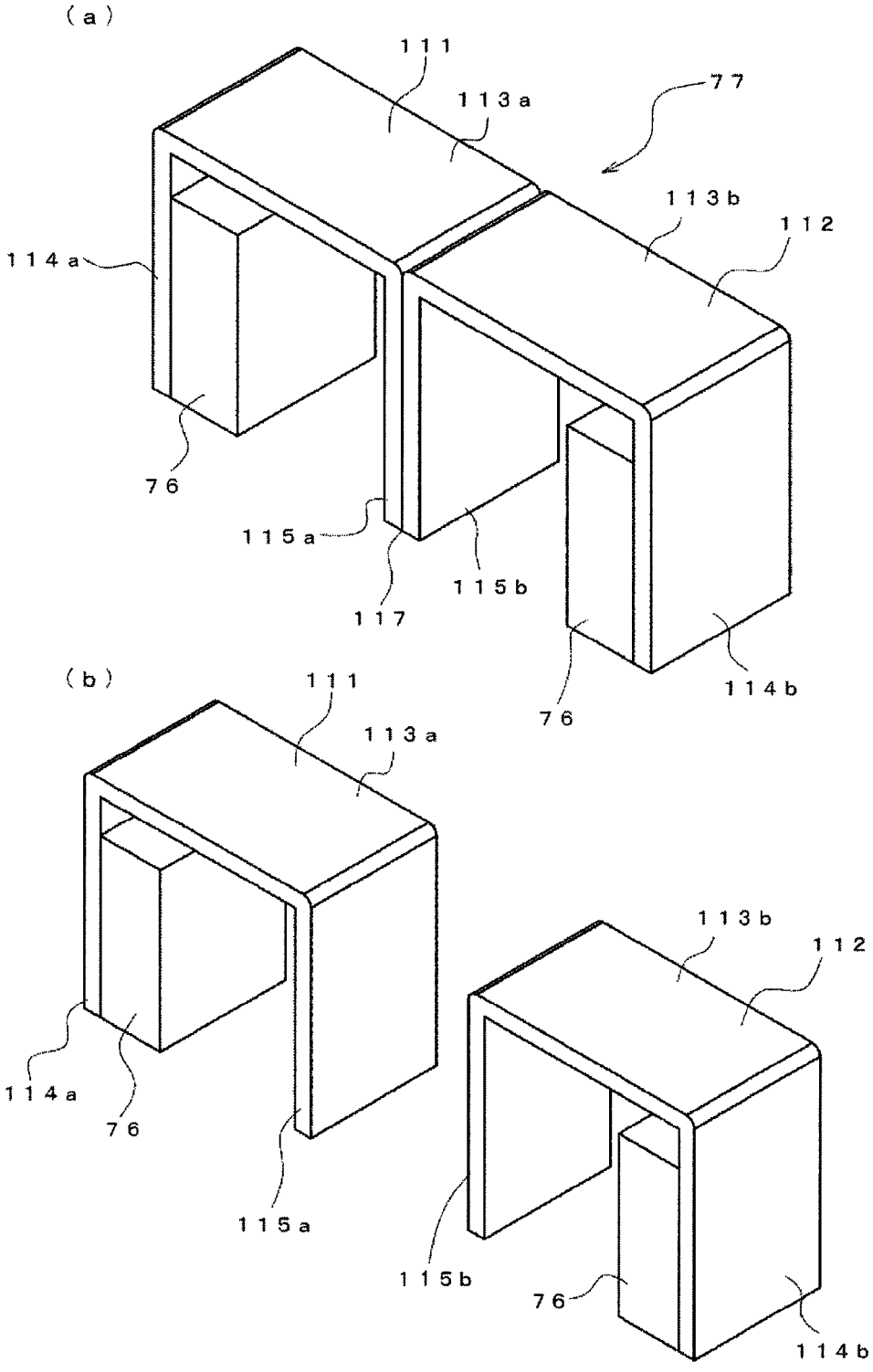
102
104a
76
105a
105b
76
104b

Fig. 14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76
115a
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(b)
111
113a
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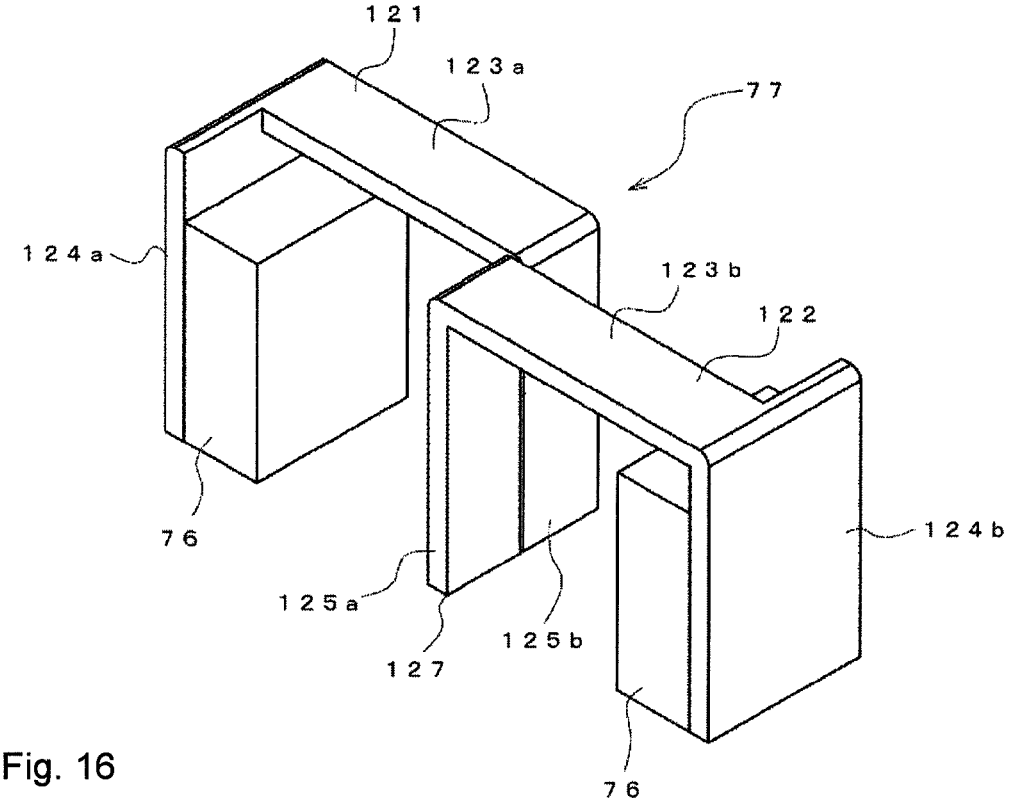
112
114a
76
115a
115b
76
114b

Fig. 15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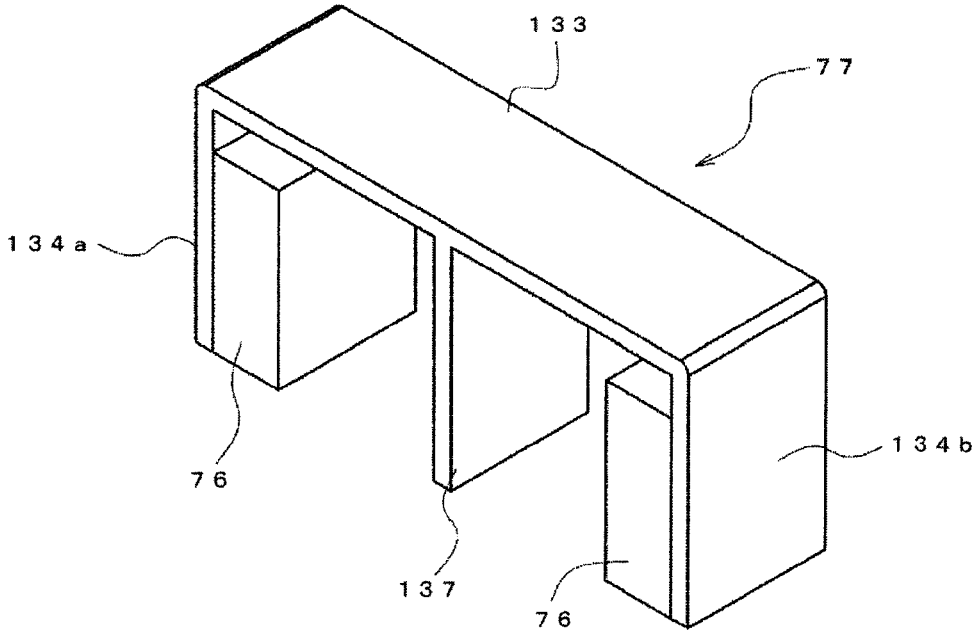
123b
122
76
124b
125a
125b
127
76

Fig. 16


133
77
134a
134b
76
137
76

# ELECTROMAGNETIC RELAY

## CROSS REFERENCE TO RELATED APPLICATION

This application claims benefit of priority to Japanese Patent Application No. 2011-055725, filed on Mar. 14, 2011 of which the full contents are herein incorporated by reference.

The present invention relates to an electromagnetic relay.

## BACKGROUND OF THE INVENTION

Conventionally, an electromagnetic relay in which an electromagnet block formed by winding a coil around an iron core with a spool interposed therebetween is magnetized or demagnetized to pivot a moving iron, which is supported pivotably by a yoke swaged and anchored to the iron core, and to drive a movable touch piece so that a movable contact opens and closes with respect to a fixed contact of a fixed touch piece arranged facing the movable touch piece is known from Japanese Unexamined Patent Publication No. 2009-87918.

In this electromagnetic relay, a permanent magnet is arranged on an upper side of a contact switching unit to generate a magnetic field between the contacts so that when an arc current generates at the time of contact opening/closing, the arc current can be extended toward the side and extinguished at an early stage.

However, the magnetic field is generated by a single permanent magnet arranged on the upper side of the contact switching unit in the conventional electromagnetic relay. The magnetic field generated downward from the N pole which is the lower side of the permanent magnet, is directed from between the contacts toward the side, and then toward the upper side along each touch piece to reach the S pole which is the upper side of the permanent magnet. Thus, there is a problem that the magnetic flux easily leaks to the peripheral space and cannot concentrate at the contact switching unit. As a result, a permanent magnet that exerts a strong magnetic force becomes necessary, which leads to increase in cost.

## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a small and inexpensive electromagnetic relay having an arc extinguishing function capable of extinguishing an arc generated at the time of contact opening/closing at an early stage.

## BACKGROUND OF THE INVENTION

According to an embodiment of an electromagnetic relay, the electromagnetic relay includes a contact switching unit formed by arranging at least two contact groups, in parallel with each other and perpendicular to a touch/separation direction of the contacts, each of the contact groups includes a pair of contacts which are adapted to touch each other and separate from each other, an electromagnet block that drives the contact switching unit to open/close the contacts, and an arc extinguishing member including a connection member made from a magnetic material and formed by a connection, of projecting sections that respectively project out from both sides of a middle part in the direction of the parallel arrangement of the contact groups and between the contact groups, and permanent magnets respectively disposed at least on the opposing positions of the projecting section located on both sides of the middle part.



The electromagnetic relay preferably includes a case to be attached to a base to cover the contact switching unit and the electromagnet block, wherein

the case includes a recessed portion to which the projecting section and the permanent magnet of the arc extinguishing member can be arranged.

Preferably, a polarity of an opposing surface of each permanent magnet and a direction in which an arc current generated at a time of contact opening/closing flow are determined so that a force of displacing toward the middle part of the connection member is generated on the arc current.

In an alternate embodiment, a polarity of an opposing surface of each permanent magnet and a direction in which an arc current generated at a time of contact opening/closing flow may be determined to be in opposite directions between the adjacent contact open/close positions.

The electromagnetic relay preferably includes a base to be attached with the contact switching unit and the electromagnet block, wherein

the contact is fixed to one end section of a touch piece that projects out from the base, and

the arc extinguishing member has the middle part of the connection member arranged near the contact on a projecting direction side of the touch piece.

According to another embodiment of the electromagnetic relay, an electromagnetic relay includes a contact switching unit having a fixed touch piece and a movable touch piece facing the fixed touch piece, an electromagnet block being magnetized or demagnetized to drive the movable touch piece so that a movable contact arranged in the movable touch piece opens/closes with respect to a fixed contact arranged in the fixed touch piece; wherein

at least two fixed touch pieces including the fixed contact are provided,

the movable touch piece includes at least a pair of contact piece portions including the movable contact, and an arc extinguishing member including a connection member having projecting sections projecting out from both sides of each touch piece portion and connected with each other via a middle part between the open/close positions of the contact and permanent magnets respectively disposed at each of the opposing positions of the projecting sections located on both sides.

In one embodiment of the electromagnetic relay, the connection member of the arc extinguishing member is formed by an opposing wall at both ends of an intermediate wall, and side parts are raised from the opposing wall side on opposite sides with respect to a central part to form the projecting section located between the contact groups at the central part of the intermediate wall.

In another embodiment of the electromagnetic relay, a flat plate-shaped wall surface portion may be configured with the projecting sections.

In yet another embodiment of the electromagnetic relay, the connection member of the arc extinguishing member includes a first connecting portion and a second connecting portion, each connecting portion being configured by forming a first side wall and a second side wall at both ends of the intermediate wall so as to face each other; and the projecting section located between the contact groups being configured by the second side walls.

In an alternate embodiment of the electromagnetic relay, the second side wall of the first connecting portion and the second side wall of the second connecting portion may configure a flat plate-shaped wall surface portion.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an electromagnetic relay according to the present embodiment.

FIG. **2** is a perspective view showing a state in which a case and an arc extinguishing member are exploded from FIG. **1**.

FIG. **3** is a perspective view showing a state in which only the case is removed from FIG. **1**.

FIG. **4** is an exploded perspective view of FIG. **1**.

FIG. **5** is an exploded perspective view showing a state in which FIG. **4** is seen from the opposite side.

FIG. **6**A is a perspective view showing a state in which a base is seen from an upper side, and FIG. **6**B is a perspective view showing a state in which the base is seen from a lower side.

FIG. **7** is an exploded perspective view of an electromagnet block and a moving iron shown in FIG. **2**.

FIG. **8** is an exploded perspective view of the electromagnet block and the moving iron shown in FIG. **2**.

FIG. **9** is a cross-sectional view at the time of contact closing showing a state in which the case is removed from FIG. **1**.

FIG. **10** is a cross-sectional view at the time of contact opening showing a state in which the case is removed from FIG. **1**.

FIG. **11** is an enlarged perspective view of a contact switching unit of FIG. **3**.

FIG. **12** is a graph showing a drawing force curve by the electromagnet block of FIG. **4** and change in the force that acts on a movable touch piece.

FIG. **13**(*a*) is a perspective view showing an arc extinguishing member according to another embodiment, and FIG. **13**(*b*) is a perspective view exploded to a first connecting portion and a second connecting portion.

FIG. **14**(*a*) is a perspective view showing an arc extinguishing member according to another embodiment, and FIG. **14**(*b*) is a perspective view exploded to a first connecting portion and a second connecting portion.

FIG. **15** is a perspective view showing an arc extinguishing member according to another embodiment.

FIG. **16** is a perspective view showing an arc extinguishing member according to another embodiment.

## DETAILED DESCRIPTION

An embodiment according to the present invention will be hereinafter described according to the accompanying drawings. In the following description, terms (e.g., terms including "up", "down", "side", "end") indicating a specific direction or position are used as necessary but the use of the terms are merely to facilitate the understanding of the invention that references the drawings, and it should be recognized that the technical scope of the invention is not to be limited by the meaning of the terms. Furthermore, the following description is merely illustrative in essence, and is not intended to limit the present invention, the applied articles and the applications thereof.

FIGS. **1** to **5** show an electromagnetic relay according to the present embodiment. The electromagnetic relay is roughly obtained by arranging an electromagnet block **2**, a contact switching unit **3**, and a moving iron **4** on a base **1** and placing a case **5** thereon.

As shown in FIG. **6**, the base **1** is formed into a rectangular shape in a plan view by a forming process on a synthetic resin material, and a first attachment section **6** and a second attachment section **7** are arranged at two areas in a longitudinal direction (hereinafter, description will be made assuming a direction extending in the longitudinal direction along a long side as X-axis, a direction extending in a short-side direction along a short side as Y-axis, and a direction extending in a height direction as Z-axis).

The first attachment section **6** is provided to attach the electromagnet block **2**, to be described later, and has a supporting recessed portion **10** formed in a recessed area **9** surrounded by a first peripheral edge wall **8** and the second attachment section **7**. On a bottom surface of the recessed area **9**, a pair of coil terminal holes **11** passing through the upper and lower surfaces are respectively formed on both sides of the supporting recessed portion **10** (short side direction of the base **1**: YY' direction). A guide portion **12** is formed in the vicinity (longitudinal direction of the base **1**) of the supporting recessed portion **10**. The guide portion **12** is configured with a pair of guide walls **13** arranged in correspondence with the short-side direction (YY' direction), and an insulating wall **14** that connects the guide walls. A guide groove **15** extending in an up and down direction is formed on each opposing surface of the guide walls **13**. The guide grooves **15** guide both side parts of a yoke **41**, to be described later. A guide recessed portion **16** is formed at a central portion of a region surrounded by the guide walls **13** and the insulating wall **14**. A section **50** to be guided of a hinge spring **44**, to be described later, is located in the guide recessed portion **16**.

The second attachment section **7** is provided to attach the contact switching unit **3**, and is formed with a base portion **17** of the same height as the first peripheral edge wall **8** of the first attachment section **6**. The base portion **17** is formed with a slit-like first terminal hole **18** that extends in the YY' direction. The first terminal hole **18** passes through only at a communicating portion **19** at two areas on both sides in the bottom surface of the base **1**, so that a movable touch piece **52**, to be described later, can be press-fitted thereto. A second peripheral edge wall **20** is formed from three sides except the first attachment section side of the base portion **17**. A portion configuring the X' direction side of the second peripheral edge wall **20** has a large thickness, and a pair of slit-like second terminal holes **21** extending in the YY' direction are respectively formed thereat. A fixed touch piece **51**, to be described later, is to be press-fitted and anchored in each second terminal hole **21**.

As shown in FIGS. **7** and **8**, the electromagnet block **2** is formed by winding a coil **24** around an iron core **22** with a spool **23** interposed therebetween.

The iron core **22** is formed into a rod-shape with a magnetic material, where a guard shaped magnet pole section **25** is formed at a lower end section and a yoke **41** is swaged and anchored at an upper end section.

The spool **23** is obtained by a forming process on a synthetic resin material, and is configured with a tubular body portion **27** that forms a center hole **26**, and guard portions (upper end guard portion **28** and lower end guard portion **29**) formed on both upper and lower end sections.

The upper end guard portion **28** has an escape groove **30** formed on the upper surface, and the center hole **26** is opened thereat. One end of the yoke **41**, to be described later, is arranged in the escape groove **30**. The center hole **26** is opened at the lower end guard portion **29**, so that the iron core **22** can be inserted therefrom.

A terminal attachment portion **31** is provided on both sides of the lower end guard portion **29**, and a terminal holding hole **32** is formed thereat. A coil terminal **36**, to be described later, is press-fitted and anchored in each terminal holding hole **32**. A step portion **33** is formed on both sides of one end of the terminal attachment portion **31**, so that a coil winding portion **39** of the coil terminal **36** press-fitted and anchored in the terminal holding hole **32** projects out. On the lower end guard portion **29** is formed with a guiding groove **34** communicating to one step portion **33** from the body portion **27** toward the side end face. One end side (winding start side) of the coil **24**

to be wound around the body portion **27** is arranged in the guiding groove **34**, and is wound around the coil winding portion **39** of the coil terminal **36** projecting out at the step portion **33**. A pair of guide projections **35** is arranged at a predetermined interval on the bottom surface of the lower end guard portion **29**. The guide projections **35** are located in the supporting recessed portion **10** of the base **1**, to play a role of positioning the spool **23**, that is, the electromagnet block **2** with respect to the base **1**.

The coil terminal **36** is formed into a flat plate shape with a conductive material, and the lower end section is formed such that the width and the thickness gradually become smaller toward the lower side. The upper end section of the coil terminal **36** is formed with a press-fit portion **37** that bulges out from one surface by press working, where the upper portion is a wide width portion **38**. The coil winding portion **39** projects out from one end of the wide width portion **38**.

The coil **24** is wound around the body portion **27** of the spool **23**, and then an insulating sheet **40** is adhered to the outer peripheral surface. One end section of the coil **24** is arranged in the guiding groove **34** of the spool **23**, and after being wound around the body portion **27** of the spool **23**, both ends are respectively wound around the coil winding portion **39** of each coil terminal **36** and then soldered.

The yoke **41** is swaged and anchored to one end of the iron core **22**. The yoke **41** is formed by bending the magnetic material to a substantially L-shape. One end section of the yoke **41** is formed with an opening **41***a* for inserting one end of the iron core **22** and swaging and anchoring the same. The other end section of the yoke **41** becomes a wide width, and a projecting section **42** is formed on both sides of the lower end section. The moving iron **4**, to be described later, is located between the projecting sections **42** and one corner functions as a fulcrum for pivotably supporting the moving iron **4**. A protrusion **43** for swaging is formed at two, upper and lower areas on the outer surface of the middle part of the yoke **41**.

The hinge spring **44** is swaged and anchored using the protrusion **43** at the middle part of the yoke **41**. However, the method of anchoring the hinge spring **44** to the yoke **41** is not limited to swaging, and may be performed with other methods such as ultrasonic welding, resistance welding, laser welding, and the like.

The hinge spring **44** includes a connecting portion **45** to be area contacted to the outer surface of the middle part of the yoke **41**. A through-hole **45***a* is formed at two areas in the connecting portion **45**, so that the protrusion **43** of the yoke **41** can be inserted and swaged therein.

The upper portion of the connecting portion **45** is an elastic contacting portion **46** that extends at a predetermined angle so as to gradually separate from the outer surface of the middle part of the yoke **41**. The elastic contacting portion **46** can elastically contact a pushing receiving portion of a card member **65** arranged in the moving iron **4**, to be described later. The elastic contacting portion **46** alleviates the generation of collision noise when the moving iron **4** returns to the original position.

The lower portion of the connecting portion **45** is an elastic support **49** including a first inclined portion **47** that extends at a predetermined angle so as to gradually separate from the outer surface of the middle part of the yoke **41**, and a second inclined portion **48** that extends at a predetermined angle so as to gradually approach the yoke side from the first inclined portion **47**. The elastic support **49** elastically supports the moving iron **4** pivotably when the second inclined portion **48** pressure contacts the moving iron **4**, to be described later.

The lower portion of the elastic support **49** is the section **50** to be guided that extends vertically downward with the moving iron **4** elastically supported by the elastic support **49**. The section **50** to be guided is arranged in the guide recessed portion **16** formed in the first attachment section **6** of the base **1**, and the hinge spring **44** is prevented from position shifting by being guided by the guide recessed portion **16**.

As shown in FIGS. **4** and **5**, the contact switching unit **3** is configured with a fixed touch piece **51** and a movable touch piece **52** in which the conductive material such as copper is press worked to a plate shape.

The fixed touch piece **51** is configured with a press-fit portion **53**, a terminal portion **54** extending to the lower side from the press-fit portion **53**, and a touch piece portion **55** extending to the upper side from the press-fit portion **53**. The press-fit portion **53** is formed with a bulging out portion **56** that bulges out from one surface by press working. The second terminal hole **21** of the base **1** can be press-fitted by the bulging out portion **56**. The terminal portion **54** has a narrower width than the press-fit portion **53** and is formed with the position shifted to one side. The touch piece portion **55** is formed with the position shifted to the side opposite to the terminal portion **54**, and has a width dimension of substantially the half of the press-fit portion **53**. A through-hole is formed at the upper end of the touch piece portion **55**, and the fixed contact **57** is swaged and fixed thereat.

The movable touch piece **52** is configured with a press-fit portion **58**, and a pair of touch piece portions **59** respectively extending to the upper side from both sides of the press-fit portion **58**. The press-fit portion **58** is formed with a bulging out portion **60** extending in the width direction at a central part in the up and down direction, similar to the fixed touch piece **51**, and can be press-fitted into the first terminal hole **18** of the base **1**. A pair of protrusions **61** that projects out downward is formed at both ends of the lower edge of the press-fit portion **58**. The touch piece portion **59** is bent at the proximate portion of the press-fit portion **58** and then extended, where a through-hole **59***a* is formed at the upper end section and the movable contact **62** is swaged and fixed therein. The movable touch piece **52** faces the fixed contact **57** of the fixed touch piece **51** in which the movable contact **62** is press-fitted into the second terminal hole **21** so as to touch and separate the fixed contact with the press-fit portion **58** press-fitted into the first terminal hole **18** of the base **1**.

As shown in FIGS. **7** and **8**, the moving iron **4** is formed into a substantially L-shape by press working a plate-like magnetic material. One end side of the moving iron **4** is a section **63** to be drawn that is drawn to the magnet pole section **25** of the iron core **22**. The leading end portion and the base portion of the section **63** to be drawn have a narrow width, and the interference of the guide projection **35** formed on the bottom surface of the spool **23** and the projecting section **42** formed on the lower end section of the yoke **41** is avoided. An opening **64** is formed on the other end side of the moving iron **4**. The hinge spring **44** is inserted to the opening **64**, and is pressure contacted to the corner of the section **63** to be drawn. The other end section of the moving iron **4** has a narrow width, and the card member **65** is integrated at the upper side of the opening **64**.

The card member **65** is made of synthetic resin material, and a first projecting section **66** formed on both sides of the upper end section of the moving iron **4** and a second projecting section **67** formed on the upper side are respectively formed on one surface where the upper end side of the integrated moving iron **4** is exposed. When the section **63** to be drawn of the moving iron **4** separates from the magnet pole section **25** of the iron core **22**, the elastic contacting portion **46** of the hinge spring **44** collides with the second projecting section **67** and then the first projecting section **66** comes into

contact with the yoke **41**. A projected thread section **68** extending in the up and down direction is formed at a predetermined interval in the width direction on the other surface of the card. A pushing portion **69** that further projects out is formed at the upper end section portion of the projected thread section **68**, so that the upper end section of the touch piece portion **55** of the movable touch piece **52** can be pushed. A shielding wall **70** that projects out more than the other surface and that extends further to the lower side is formed at the lower end section of the card member **65**.

As shown in FIG. **2**, the case **5** is made of a synthetic resin material and formed into a box-shape having an opened lower surface. A sealing hole **71** is formed at the corner of the upper surface of the case **5**. The sealing hole **71** is thermally sealed after sealing the fitting portion of the base **1** and the case **5**. A slit-like recessed portion **72** is formed on both sides and the central part at the edge of the upper surface (side opposite to the sealing hole **71**) of the case **5**. A recessed area **73** that is depressed from the upper surface is formed between the recessed portions **72**, and a protrusion **74** is formed at the central part of the respective upper surface.

An arc extinguishing member **75** is attached to the case **5** using the recessed portion **72** and the recessed area **73**.

The arc extinguishing member **75** is configured with a pair of permanent magnets **76** arranged at a predetermined interval to extinguish an arc, and a connection member **77** made of a magnetic material for magnetically connecting the permanent magnets **76**.

Each of the permanent magnets **76** has a substantially cuboid shape, and are arranged so that the opposing surfaces have different polarities while being attached to the inner surfaces of the opposing walls **78** of the connection member **77**. The polarities of the opposing surfaces are to be set such that the direction of the force acting on the arc current is directed toward an intermediate wall **79** of the connection member **77**, according to the difference in the direction the current flows between the contacts. According to the configuration, the arc current can be deformed to a position where the adverse affect of the arc current is applied the least, and then extinguished

The connection member **77** is bent such that the end sides face each other by press working a plate-like magnetic material. The permanent magnet **76** is adsorbed and fixed by its magnetic force to the inner surface of each opposing wall **78**. An intermediate projecting section **80** located between the opposing walls **78** is formed on the intermediate wall **79** of the connection member **77** by raising the side parts from different end sides. Each intermediate projecting section **80** is located at the central part of the opposing walls **78** and projects out between the contact open/close positions to play a role of shortening the magnetic path. In other words, the magnetic flux generated from the permanent magnet **76** forms a closed loop in the magnetic circuit that passes through the intermediate wall **79** and each opposing wall **78** through the intermediate projecting section **80** and returns to the permanent magnet **76**.

Thus, according to the arc extinguishing member **75**, not only the pair of permanent magnets **76**, but also the connection member **77** for magnetically connecting the permanent magnets **76** is arranged. The magnetic circuit is thus formed, and the magnetic flux leakage is less likely to occur. Furthermore, the magnetic path can be set short by arranging the intermediate projecting section **80**. Therefore, the magnetic efficiency can be enhanced. As a result, even if arc is generated at the time of contact opening/closing, the arc is extended toward the side by the Fleming's left hand rule, and can be extinguished in a short period of time.

An assembly method of the electromagnetic relay having the above configuration will now be described.

The coil **24** is wound around the body portion **27** of the spool **23** and the coil terminal **36** is press-fitted and fixed to the lower end guard portion **29**. The ends of the coil **24** are wound and soldered to the coil winding portion **39**. The iron core **22** is inserted to the center hole **26** of the spool **23** from the lower end side, and the yoke **41**, in which the hinge spring **44** is attached in advance, is swaged and anchored to a portion projecting out from the upper end. The electromagnet block **2** is thereby completed.

In the completed electromagnet block **2**, the moving iron **4** is pivotably supported at the lower end section of the yoke **41** using the hinge spring **44**. In this state, the first projecting section **66** of the card member **65** integrated with the moving iron **4** can come into contact with the yoke **41**, and the elastic contacting portion **46** of the hinge spring **44** can touch and separate the second projecting section **67** of the card member **65**. The electromagnet block **2** attached with the moving iron **4**, and the contact switching unit **3** are then attached to the base **1**.

In the attachment of the electromagnet block **2**, the coil terminal **36** is press-fitted into the coil terminal hole **11** of the base **1**, and the side parts of the yoke **41** are inserted to the guide groove **15** of the guide wall **13**. In the attached state, the guide projection **35** is located in the supporting recessed portion **10**, and the electromagnet block **2** is located in the YY' direction. The lower end face of the projecting section **42** of the yoke **41** and the bottom surface of the terminal attachment portion **31** respectively come into contact with the bottom surface of the recessed area **9** of the base **1**. Thus, a gap in which the moving iron **4** can pivot is formed between the bottom surface of the recessed area **9** of the base **1** and the bottom surface of the lower end guard portion **29** of the spool **23**. The shielding wall **70** of the card member **65** integrated with the moving iron **4** is then arranged over the insulating wall **14** of the base **1**. In this case, the insulating property between the electromagnet block **2** and the contact switching unit **3** is sufficiently ensured by the guide wall **13** and the insulating wall **14** of the base **1**, and the upper portion of the card member **65** and the shielding wall **70**.

In the attachment of the contact switching unit **3**, the press-fit portion **58** of the movable touch piece **52** is press-fitted into the first terminal hole **18** of the base **1**. In the attachment of the movable touch piece **52**, the protrusion **61** is located in the communicating portion **19**, so that the attachment state of the movable touch piece **52** can be checked from the bottom surface of the base **1**. The pushing portion **69** of the card member **65** attached first is pressure contacted to the upper end section of the movable touch piece **52**, and the moving iron **4** is located at an initial position where the section **63** to be drawn is spaced apart from the magnet pole section **25** of the iron core **22** by the elastic force of the movable touch piece **52**.

The terminal portion **54** of the fixed touch piece **51** is then inserted to the second terminal hole **21** of the base **1**, and the press-fit portion **53** is press-fitted and fixed. In this state, the fixed touch piece **51** faces the movable touch piece **52** with a predetermined space, so that the movable contact **62** can touch and separate the fixed contact **57**.

The arc extinguishing member **75** is then attached to the case **5**. In the attachment of the arc extinguishing member **75**, the opposing wall **78** and the permanent magnet **76** of the connection member **77**, and the intermediate projecting section **80** are respectively inserted to each recessed portion **72** formed in the case **5** with the permanent magnet **76** attached to the opposing wall **78** of the connection member **77**. The

case **5** attached with the arc extinguishing member **75** is placed over the base **1**, and the fitting portions thereof are sealed.

The internal space is to be in a sealed state by thermally sealing the sealing hole **71**. However, use can be made with the internal space communicating with the surrounding atmosphere and with the sealing hole **71** opened.

The operation of the electromagnetic relay having the above configuration will now be described.

In a state that a current does not flow in the coil **24** and the electromagnet block **2** is demagnetized, the section **63** to be drawn is located at an initial position spaced apart from the magnet pole section **25** of the iron core **22** with the fulcrum, at which the moving iron **4** is supported by the yoke **41** by an elastic force of the movable touch piece **52**, as the center. Therefore, the opened state in which the movable contact **62** is spaced apart from the fixed contact **57** is maintained.

If a current flows in the coil **24** and the electromagnet block **2** is magnetized, the moving iron **4** has the section **63** to be drawn to the magnet pole section **25** of the iron core **22** and is pivoted against the biasing force of the movable touch piece **52**, as shown in FIG. **9**. The movable touch piece **52** is thereby elastically deformed, and the movable contact **62** closes with respect to the fixed contact **57** of the fixed touch piece **51**.

If the current flow in the coil **24** is shielded and the electromagnet block **2** is demagnetized, the moving iron **4** loses the drawing force of the iron core **22** and pivots by the elastic force of the movable touch piece **52**. In this case, the second projecting section **67** formed on the card member **65** of the moving iron **4** first collides with the elastic contacting portion **46** of the hinge spring **44**. The second projecting section **67** is made of synthetic resin, and the elastic contacting portion **46** elastically deforms. Furthermore, the contacting state of the second projecting section **67** and the elastic contacting portion **46** is obtained at an early stage from the start of the pivoting of the moving iron **4**. Therefore, the collision sound barely generates. The first projecting section **66** made of synthetic resin comes into contact with the middle part of the yoke **41** while elastically deforming the elastic contacting portion **46** by further pivoting the moving iron **4**. Thus, the pivoting speed of the moving iron **4** is reduced, and the generation of collision noise is sufficiently suppressed. Thus, the moving iron **4** can be smoothly returned to the initial position without generating the collision noise, and the movable contact **62** is located at the opened position spaced apart from the fixed contact **57**.

The arc sometimes generates between the contacts when opening the contacts. In this case, since the arc extinguishing member **75** is arranged at the periphery of the contact opening/closing region, the generated arc is rapidly extinguished.

In other words, the magnetic flux generated from the N pole of each permanent magnet **76** flows through the magnetic circuit of passing through the intermediate wall **79** via the intermediate projecting section **80** of the connection member **77**, and returning to the S pole of each permanent magnet **76** from the opposing wall **78**. Each magnetic circuit configures a closed loop, and there is barely any magnetic flux leakage to the periphery. The magnetic force thus can be effectively acted on the contact open/close position, that is, the arc generated between the contacts due to the presence of the intermediate projecting section **80**. As a result, the force acts in the direction perpendicular to the contact opening direction on the generated arc due to the Fleming's left hand rule, and the arc is greatly extended and thus can be rapidly extinguished.

Since the movable touch piece **52** is configured to open and close the fixed touch pieces **51**, the arc current at the time of the contact opening flows in the direction shown in FIG. **11**, whereby the magnet poles of the permanent magnets **76** are set to be different poles on the opposing surfaces so that the magnetic flux direction capable of deforming the arc toward the intermediate wall of the connection member **77** is obtained. That is, the arc can be more reliably extinguished by deforming the arc toward the intermediate wall of the connection member **77**. Therefore, when the configuration of the contact switching unit **3** differs, the magnet poles of the permanent magnets **76** are to be set according to the difference.

The operation voltage of the electromagnet block **2** can be adjusted in the following manner.

In other words, the operation voltage of the electromagnet block **2** can be suppressed by changing the inclination angle of the elastic contacting portion **46** of the hinge spring **44**. Specifically, when the inclination angle of the elastic contacting portion **46** with respect to the yoke **41** is made large, the position of the operation point can be changed with respect to the change (drawing force curve) in the force acting on the section **63** to be drawn of the moving iron **4** by the magnetic field generated from the magnet pole section **25** of the iron core **22**, as shown in the graph of FIG. **12**. That is, the force from when the contacts are opened until the elastic contacting portion **46** comes into contact with the first projecting section **66** can be made small to suppress the force required at that time by making the inclination angle of the elastic contacting portion **46** large. As a result, the operation voltage of the electromagnet block **2** can be suppressed so that the drawing force curve changes at a position smaller than the illustrated position.

The present invention is not limited to the configuration described in the above embodiment, and various changes can be made.

For example, in the embodiment described above, the movable touch piece **52** is configured with a pair of touch pieces extending from the press-fit portion **37**, but may be configured with two members (two movable touch pieces **52**). Furthermore, the fixed touch piece **51** is configured with two members, but may have a continuous integrated configuration, similar to the movable touch piece **52**.

The combination of the movable touch piece **52** and the fixed touch piece **51** may be one group of combination or may be three or more groups of combinations.

The arc extinguishing member **75** may be configured as below.

FIG. **13** shows arc extinguishing member **75***a* in which the connection member **77** is configured with a first connecting portion **101** and a second connecting portion **102**. At one end of each connecting portion **101**, **102** is formed a first side wall **104***a*, **104***b*, similar to the opposing wall of the embodiment described above, that is bent at right angle from an intermediate wall **103***a*, **103***b*. At the other end of each connecting portion **101**, **102** is formed a second side wall **105***a*, **105***b* in which only a half in the width direction is bent. A step difference (depressed portion **106***a*, **106***b*) having a thickness of the second side wall **105***a*, **105***b* is formed on an end face on the second side wall **105***a*, **105***b* side of the intermediate wall **103***a*, **103***b*. The first connecting portion **101** and the second connecting portion **102** are arranged to form a substantially E shape by aligning the second side walls **105***a*, **105***b* to the step difference. In this case, not only the side parts, as in the embodiment described above, but also a flat plate-shaped intermediate projecting section **107** that extends entirely can be formed with the second side wall **105***a*, **105***b* of each

connecting portion **101**, **102**. The permanent magnet **76** is attached to the inner surface of each first side wall **104***a*, **104***b* by magnetic force.

According to the configuration, the magnetic flux leakage can be more effectively prevented compared to the above-described embodiment, and the magnetic flux can be sufficiently concentrated between the contacts without using the permanent magnet **76** having a very large magnetic force.

Similar to FIG. **13**, the connection member **77** is configured with a first connecting portion **111** and a second connecting portion **112** in FIG. **14**. However, the difference lies in that a second side wall **115***a*, **115***b* does not have a configuration in which only a half is bent, but has a configuration of being entirely bent at right angle from an intermediate wall **113***a*, **113***b*, similar to a first side wall **114***a*, **114***b*. The first connecting portion **111** and the second connecting portion **112** are used with the outer surfaces of the second side walls **115***a*, **115***b* brought into contact to form an intermediate projecting section **117**.

According to the configuration, a closed loop of the magnetic circuit can be formed at each contact open/close position of two groups, so that the magnetic flux leakage can be more effectively prevented.

In FIG. **15**, the connection member **77** is configured with a first connecting portion **121** and a second connecting portion **122**, substantially similar to the configuration of the connection member **77** according to the embodiment described above. Each connecting wall **121**, **122** includes a first side wall **124***a*, **124***b*, an intermediate wall **123***a*, **123***b*, which has a width of half of the first side wall **124***a*, **124***b*, and a second side wall **125***a*, **125***b* formed by bending the intermediate wall **123***a*, **123***b* at right angle. The first connecting portion **121** and the second connecting portion **122** are used with the side surfaces of the second side walls **125***a*, **125***b* brought into contact to form an intermediate projecting section **127**.

According to the configuration, the intermediate projecting section **127** can be arranged not only at the side parts, as in the embodiment described above, and the intermediate projecting section **127** can be arranged over substantially the entire surface, similar to FIG. **13**. Thus, similar to FIG. **13**, the magnetic flux leakage can be effectively prevented.

In FIG. **16**, an intermediate projecting section **137** is formed with a flat plate integrally projecting out from a central part of an intermediate wall **133**. The intermediate projecting section **137** may be integrated with a plate material having the same shape as the opposing walls **134***a*, **134***b* to a member having a substantially horseshoe shape formed with an intermediate wall **133** and opposing walls **134***a*, **134***b* by welding, adhering, and the like at the central part of the intermediate wall **133**, or may be simultaneously formed with the opposing walls at the time of press working. According to the configuration, the magnetic flux can be concentrated at the contact open/close position while effectively preventing the magnetic flux leakage to a maximum without configuring with two members or without forming a gap, and the like, as in the embodiments described above.

According to the present invention, the connection member is arranged at the periphery of the contact open/close position, and the permanent magnets are arranged at the opposing portions, so that the magnetic field generated from the permanent magnets can be effectively concentrated at the contact open/close position. In particular, since the projecting section of the connection member is located between the contact open/close positions, the length of the generated magnetic flux that passes through space can be reduced to suppress the occurrence of the leakage magnetic flux, and the magnetic flux can be concentrated at the contact open/close position. Thus, even if the arc current is generated at the time of contact opening/closing, the arc current can be deformed to the upper side by the magnetic field and extinguished at an early stage.

There has thus been shown and described an electromagnetic relay using the same which fulfills all the advantages sought therefore. Many changes, modifications, variations and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification and the accompanying drawings which disclose the preferred embodiments thereof. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, which is to be limited only by the claims which follow.

Although the invention has been described in detail for the purpose of illustration based on what is currently considered to be the most practical and preferred embodiments, it is to be understood that such detail is solely for that purpose and that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the appended claims. For example, it is to be understood that the present invention contemplates that, to the extent possible, one or more features of any embodiment can be combined with one or more features of any other embodiment.

What is claimed is:

**1**. An electromagnetic relay comprising:

a contact switching unit formed by arranging at least two contact groups in parallel with each other and perpendicular to a touch/separation direction of the contacts, each of the contact groups includes a pair of contacts which are adapted to touch each other and separate from each other;

an electromagnet block adapted to drive the contact switching unit to open/close the contacts; and

an arc extinguishing member including a connection member made from a magnetic material and formed by a) a connection of projecting sections that respectively project out from both sides of a middle part of said connection member in the direction of the parallel arrangement of the contact groups and between the contact groups, and b) opposing walls that respectively project out from ends of said connection member, and permanent magnets respectively affixed by their magnetic force to the opposing walls.

**2**. The electromagnetic relay according to claim **1**, further comprising a case to be attached to a base to cover the contact switching unit and the electromagnet block, the case includes a recessed portion to which the projecting sections and the permanent magnet of the arc extinguishing member are arranged.

**3**. The electromagnetic relay according to claim **2**, wherein a polarity of an opposing surface of each permanent magnet and a direction in which an arc current generated at a time of contact opening/closing flow are determined so that a force of displacing toward the middle part of the connection member is generated on the arc current.

**4**. The electromagnetic relay according to claim **2**, wherein a polarity of an opposing surface of each permanent magnet and a direction in which an arc current generated at a time of contact opening/closing flow are determined to be opposite directions between the adjacent contact open/close positions.

**5**. The electromagnetic relay according to claim **1**, wherein a polarity of an opposing surface of each permanent magnet and a direction in which an arc current generated at a

time of contact opening/closing flow are determined so that a force of displacing toward the middle part of the connection member is generated on the arc current.

**6**. The electromagnetic relay according to claim **1**, wherein

a polarity of an opposing surface of each permanent magnet and a direction in which an arc current generated at a time of contact opening/closing flow are determined to be opposite directions between the adjacent contact open/close positions.

**7**. The electromagnetic relay according to claim **1**, further comprising a base to be attached with the contact switching unit and the electromagnet block, wherein

the contact is fixed to one end section of a touch piece that projects out from the base, and

the arc extinguishing member has the middle part of the connection member arranged near the contact on a projecting direction side of the touch piece.

**8**. The electromagnetic relay according to claim **1**, wherein

the connection member of the arc extinguishing member is formed by an opposing wall at both ends of an intermediate wall, and side parts are raised from the opposing wall side on opposite sides with respect to a central part to form the projecting section located between the contact groups at the central part of the intermediate wall.

**9**. The electromagnetic relay according to claim **1**, wherein

the connection member of the arc extinguishing member includes a first connecting portion and a second connecting portion, each connecting portion being configured by forming a first side wall and a second side wall at both ends of the intermediate wall so as to face each other; and

the projecting section located between the contact groups is configured by the second side walls.

**10**. The electromagnetic relay according to claim **9**, wherein

the second side wall of the first connecting portion and the second side wall of the second connecting portion define a flat plate-shaped wall surface portion.

**11**. An electromagnetic relay comprising:

a contact switching unit having a fixed touch piece and a movable touch piece facing the fixed touch piece;

an electromagnet block adapted to be magnetized or demagnetized and to drive the movable touch piece so that a movable contact arranged in the movable touch piece opens/closes with respect to a fixed contact arranged in the fixed touch piece, wherein at least two fixed touch pieces have the fixed contact;

the movable touch piece includes at least a pair of contact piece portions including the movable contact, and

an arc extinguishing member including a) a connection member having projecting sections projecting out from both sides of each touch piece portion and connected with each other via a middle part of said connection member between the open/close positions of the contact, and b) opposing walls that respectively project out from ends of said connection member, and permanent magnets respectively affixed by their magnetic force to the opposing walls.

**12**. The electromagnetic relay according to claim **1**, wherein

the connection member of the arc extinguishing member is formed by an opposing wall at both ends of an intermediate wall, and side parts are raised from the opposing wall side on opposite sides with respect to a central part to form the projecting section located between the contact groups at the central part of the intermediate wall.

**13**. The electromagnetic relay according to claim **12**, wherein

a flat plate-shaped wall surface portion is configured by the projecting sections.

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